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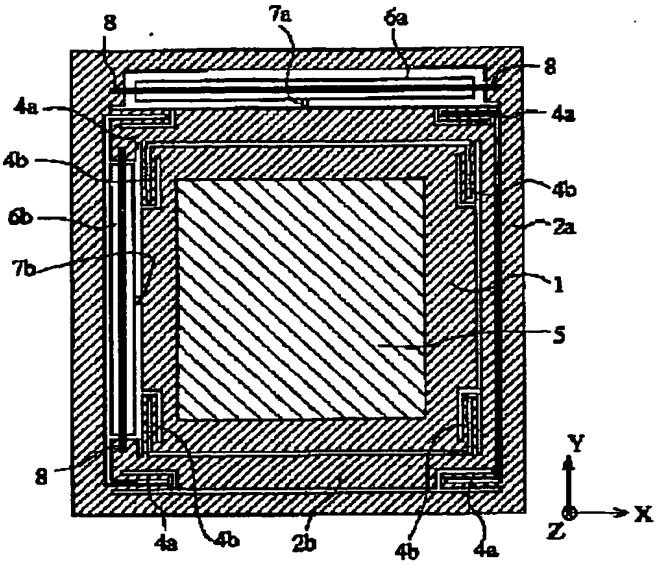
TITLE : SOLID-STATE IMAGE-PICKUP DEVICE AND DIGITAL IMAGE-PICKUP DEVICE USING THE SAME





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SOLUTION: This device is configured by providing frames 2a, 2b, a stage 1 that is supported by plural elastic springs connecting to the frames and a solid-state image-pickup element 5 provided to the stage 1. Furthermore, the device is provided with at least one actuator (both-end support dimorph elements 6a, 6b) which consists of a long member whose both-ends are fixed to the frames and which is bent in response to a given drive signal. The solid-state image- pickup element 5 is moved in parallel with an image-pickup face, by bending the actuator in a projected and/or concaved way with respect to the stage.

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## (54) SOLID-STATE IMAGE-PICKUP DEVICE AND DIGITAL IMAGE-PICKUP DEVICE USING THE SAME

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PROBLEM TO BE SOLVED: To provide a small-sized light weight solid-state image-pickup device in which where a high resolution is obtained by using a solid-state image-pickup element whose number of pixels is limited and a mobile device for the solid-state image-pickup element is simply assembled as an efficient mount form.
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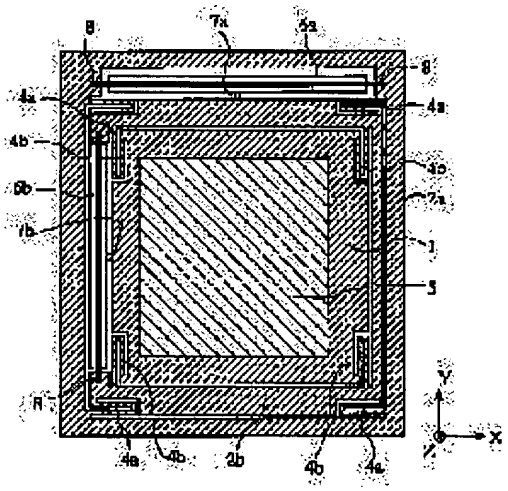

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* NOTICES *



## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to digital image pick-up devices by which especially small and lightweight-izing are demanded, such as a digital still camera and a video camera, with respect to the solid state camera with which high resolution is obtained using the solid state image sensor of the limited number of pixels.
[0002]
[Background of the Invention] On the semiconductor substrate, two or more photo detectors carry out a two-dimensional array, and consist of solid state image sensors represented by CCD and the MEJI sensor. The resolution of such a solid state image sensor having un-arranged [ that it is fairly low compared with the resolution of the image pick-up device for which **** used the film by the manufacturing technology ]. In order to cancel such un-arranging from a different viewpoint from a manufacturing technology, a solid state image sensor is moved in the right-angled direction to an optical axis at the period when image pick-up actuation is not made, and the attempt which is going to obtain high resolution by compounding the image before and behind migration is made. The method which drives with an electromagnet the moving coil fixed to the (i) solid state image sensor side as a migration device of such a solid state image sensor, for example, and the method driven by the (ii) piezoelectric device are proposed.
[0003] However, it was unsuitable for portable equipments as which a low power and lightweight-ization are required greatly current required for the drive of a moving coil ] by the method of (i) since the weight of an electromagnet is heavy, such as a video camera and a digital still camera. On the other hand, although there are a method which uses a laminating actuator, and a method using a bimorph actuator as method of (ii), the bimorph actuator is excellent in the viewpoint of a miniaturization and lightweight-izing. An example of conventional image pick-up equipment which used the bimorph actuator for drawing 15 is shown (refer to JP,60-18958,A). With the image pick-up equipment of drawing 15 , the solid state image sensor 94 on a stage 93 is vibrated the whole stage 93 in the single direction F parallel to a light-receiving side with two bimorph actuators 92a and 92b attached in the frame 91. For this reason, although the mass of the bigger stage 93 than the self-weight of a solid state image sensor 94 was added to the mass for a mechanical component, since the self-resonant frequency of a drive system was as low as about 300-400Hz, migration of a solid state image sensor with few ringings was difficult with the image pick-up equipment of drawing 15 at high speed. Moreover, the image pick-up equipment shown in drawing 15 was unsuitable for photography in a quick shutter speed. Moreover, in order to take out the video signal from a solid state image sensor, it was difficult to need a flexible printed circuit board to avoid the complexity of a mounting device, and in case it applied to a pocket device for this reason, it was disadvantageous in the viewpoint of the manufacturing cost at the time of a miniaturization and mass production.
[0004] Moreover, in the bimorph actuator using ferroelectric elements, such as titanic-acid lead zirconate (PZT), when it is, if possible, going to enlarge drive distance per unit driver voltage especially, a ferroelectric material with a big piezoelectric constant is needed. However, the temperature coefficient of the electromechanical coupling coefficient of the ferroelectric material which generally has such a property had the defect that it was large and the effect of ambient temperature was easy to receive fluctuation of drive distance. For this reason, the device using such a bimorph actuator was unsuitable for the pocket device of which the actuation stabilized in the radical of extensive temperature environment is required. Furthermore, it was unsuitable for the use to the advanced digital image pick-up device which has the necessity of changing a migration period and migration length into arbitration according to photography conditions, also from having characteristic troubles, such as a big hysteresis and a creep, in change of the drive distance over driver voltage.
[0005]
[Objects of the Invention] The purpose of this invention is offering the solid state camera which can obtain high resolution using the solid state image sensor of the limited number of pixels. Other purposes of this invention are being an efficient mounting gestalt, being able to assemble the migration device of a solid state image sensor simply, and offering a small and lightweight solid state camera moreover. The purpose of further others of this invention is using the above-mentioned solid state camera, and is offering portable digital image pick-up devices, such as a small and lightweight digital still camera and a video camera, especially.
[0006]
[Summary of the Invention] The stage where solid-state ****** of this invention is held with two or more elastic springs connected to one frame and this frame, It has solid state image sensors formed in this stage, such as CCD and MOS mold image sensors, and is constituted (the solid state camera of this configuration is hereafter called "solid state camera with one frame").

Moreover, the 1st frame, The 2nd frame held with two or more elastic springs connected to this 1st frame, It has the stage held with two or more elastic springs connected to this 2nd frame, and the solid state image sensor formed in this stage, and is constituted (the solid state camera of this configuration is hereafter called "solid state camera with two frames").

[0007] In a solid state camera with a solid state camera with one frame, and two frames, a frame and a stage can be formed from a single substrate. Moreover, a frame and a stage can be formed from a single substrate and the single substrate concerned can also form a solid state image sensor with the substrate according to individual. In this case, a solid state image sensor substrate is pasted up or welded to the stage surface. With a solid state camera with one frame, an elastic spring restrains motions other than the predetermined migration direction of a stage, and restrains motions other than the predetermined migration direction of the 1st frame or a stage with a solid state camera with two frames.

[0008] Both ends were fixed to the frame, the solid state camera with one frame consisted of a longitudinal member which curves according to the given driving signal, and the part except the fixed end of this longitudinal member is equipped with at least one actuator which the stage fixed or contacted by pressing. By incurvating this actuator to convex and/or a concave to a stage, a solid state image sensor moves in parallel to an image pick-up side. In a solid state camera with one frame, an actuator can usually carry out single dimension migration of the solid state image sensor. Moreover, as for the solid state camera with two frames, both ends are fixed to the 1st frame. At least one actuator with which it consisted of a longitudinal member which curves according to the given driving signal, and the 2nd frame fixed or contacted the part except the fixed end of this longitudinal member by pressing, It was fixed to the 2nd frame, both ends consisted of a longitudinal member which curves according to the given driving signal, and the part except the fixed end of this longitudinal member is equipped with at least one actuator which the stage fixed or contacted by pressing. By incurvating each actuator to convex and/or a concave to a stage, a solid state image sensor moves in parallel to an image pick-up side. The actuator fixed to the 1st frame carries out single dimension migration of the 2nd frame, by carrying out single dimension migration of the solid state image sensor, the actuator fixed to the 1st frame and the actuator fixed to the 2nd frame can cooperate, and the actuator fixed to the 2nd frame can move [ actuator ] a 2-dimensional solid state image sensor.

[0009] Although both the actuators used for a solid state camera with a solid state camera with one frame and two frames can be formed with a bimorph element, a bimetallic element, or a shape memory alloy, it is suitable for them to use the bimorph piezoelectric device (henceforth a "both-ends support bimorph element") of a both-ends support mold. A bimorph piezoelectric device has the structure which stuck the board of a piezoelectric device with which the directions of polarization differ on both sides of the metal plate called SIMM, and the both-ends support bimorph element which supports the both ends of SIMM performs crookedness actuation which curves to positive/negative centering on the center section of the element by applying the voltage of amphipathy. For this reason, a solid state image sensor is electrically movable by connecting to the end of a solid state image sensor substrate a part for the center section from which the largest displacement of a both-ends support bimorph element is obtained. It is easy to arrange the actuator with which both ends were fixed to the 1st frame, and the actuator of each other with which both ends were fixed to the 2nd frame with the sense of 90 degrees in a solid state camera with two frames. For this reason, resolution can be made high by compounding the image which the more advanced position control of became possible and was photoed in a different location as compared with the conventional example.

[0010] In a solid state camera with one frame, one frame, the stage (henceforth a "solid state image sensor substrate") in which the solid state image sensor was formed, and an elastic spring can be formed by one using micro machine technology from single substrates, such as a silicon substrate. Moreover, with image pick-up equipment with two frames, the 1st and 2nd frames, the stage in which the solid state image sensor was formed, and an elastic spring can be formed by one using micro machine technology from single substrates, such as a silicon substrate. Moreover, in a solid state camera with a solid state camera with one frame, and two frames, a solid state image sensor can be formed in one with neither of a frame and an elastic spring, but it can form with the substrate according to individual (this is also called "solid state image sensor substrate"), and this can also be attached in the stage surface by adhesion or welding. With the above-mentioned micro machine technology, the elastic spring which has a uniform load rate can be collectively produced in large quantities by forming an elastic spring in a frame, a stage, and one. In addition, silicon, diacid-ized silicon, sapphire, lithium niobate, or gallium arsenide can be used as a material of the above-mentioned solid state image sensor substrate. In a solid state camera with one frame, it can have a location detection means for getting to know the single dimension location of a stage, and a position control means for sending out a driving signal to the aforementioned actuator so that a solid state image sensor may be located in a predetermined coordinate based on the positional information outputted from this location detection means.

[0011] In a solid state camera with two frames, based on the positional information outputted from the location detection means and this location detection means for getting to know the 2-dimensional location of a stage, it can have a position control means for sending out a driving signal to the actuator fixed to the 1st and 2nd aforementioned frames so that a solid state image sensor may be located in a predetermined coordinate. The above-mentioned position control means can move a solid state image sensor to a desired location by driving an actuator. A position control means can equip with and constitute the driver voltage amplifying circuit which generates the voltage which drives each actuator with the output of the D/A converter which outputs the analog signal corresponding to the position control data for moving a solid state image sensor to an arbitration location, the error amplifier which amplifies the difference of the output of this D/A converter, and the output of a location detection means, and this error amplifier. A position control means can perform exact position control of a solid state image sensor by making it the difference of an input of error amplifier become zero.

[0012] The position sensor which can know the movement magnitude of a solid state image sensor substrate is more specifically formed in the surface of a solid state image sensor substrate, and it is desirable to have the positioning unit which can carry out

feedback control of the driver voltage applied to an actuator using the positional information acquired from the position sensor concerned. It becomes possible to solve the problem which originates in various nonlinearity, such as the temperature characteristic peculiar to the bimorph actuator which was a problem, and a hysteresis or a creep, by carrying out like this by the migration device of the solid state image sensor using the bimorph actuator of the conventional example, and the suitable highly efficient solid state camera for the pocket image pick-up device by which application by extensive temperature environment is called for can be offered. In this case, a location detection means can consist of electrostatic capacity between a stage and the parallel plate electrode which prepared the gap and has been placed in a fixed position to the location detection means concerned so that the location of a solid state image sensor can be known.

[0013] The signal line for taking out the detecting signal from a location detection means to the exterior of a frame can be formed, and also the signal line for taking out the power supply and image pick-up output signal of a solid state image sensor to the exterior of a frame can also be formed in the surface of an elastic spring. the solid state camera which has the conventional migration device by forming various kinds of above-mentioned signal lines in the surface of an elastic spring with a solid state camera with a solid state camera with one frame, and two frames since special wiring components, such as a flexible printed circuit board, are made unnecessary -- comparing -- components mark not only being reduced sharply but a migration device -- a miniaturization -- and-izing can be carried out [ lightweight ]. For this reason, it becomes possible to reduce the mass for a mechanical component even to the value near the solid state image sensor substrate itself as compared with a solid state camera with the conventional migration device, and the self-resonant frequency of a drive system can be easily improved from conventional about 300-400Hz to 2kHz or more. For this reason, when moving in the shape of a step in connection with this high-speed migration not only being attained, but, it becomes possible to reduce sharply the problem of the ringing which was a problem. It is suitable for the use of a digital still camera as which high-speed migration of a solid state image sensor is required especially and for which photography by quick shutter speed is needed.

[0014] The solid state camera which mentioned above the digital image pick-up device of this invention, and the A/D converter which changes the analog output signal of the solid state image sensor of the solid state camera concerned into a digital signal, The buffer memory which has two or more record sections which record the output of an A/D converter, It is what is constituted by having a data compression means to compress the data recorded on buffer memory, and a data-logging means to record the output data of a data compression means. Whenever a solid state camera carries out a single dimension or 2-dimensional migration in the direction right-angled to an optical axis, it is characterized by recording image pick-up data on the record section where buffer memory differs.

[0015] The digital image pick-up device of this invention can equip with and constitute the shutter which incorporates further the image which carries out incidence to a solid state image sensor, and the image composition means for restoring the data inside buffer memory to the 2-dimensional image corresponding to the pixel location of a solid state image sensor. In this case, while a shutter opens and closes (while it is open), whenever it moves a solid state image sensor and a solid state image sensor moves to at least two desired locations, an image composition means restores the image pick-up data which recorded photography data on buffer memory and was recorded on the buffer memory concerned to a 2-dimensional image, and a data compression means compresses the restored data concerned.

[0016]

[Example]

The [1st example] Drawing 1 is suitable drawing to explain the 1st example of this invention, and is drawing showing the outline of a solid state camera with two frames. A right-handed coordinate system is adopted in drawing 1 , the direction of a right hand is determined as the positive direction of the X-axis, and the positive direction of a Y-axis and hand front are determined for above as the positive direction of the Z-axis. In drawing 1 , a stage 1 is supported by 2nd frame 2b through elastic spring 4b, 2nd frame 2b is supported by 1st frame 2a through elastic spring 4a, and the solid state image sensor 5 is formed on the stage 1. moreover, between 1st frame 2a and 2nd frame 2b Both ends are fixed to the frame 2a concerned for an actuator (both-ends support bimorph element 6a). A center section fixes to the flank of 2nd frame 2b, and is prepared. And between 2nd frame 2b and a stage 1 Both ends are fixed to the frame 2b concerned for an actuator (both-ends support bimorph element 6b), and a center section fixes to the flank of a stage 1, and it is prepared. In drawing 1 , by using silicon micro machine technology for a single silicon substrate, the portions of the stage 1 except the both-ends support bimorph elements 6a and 6b, frame 2a, 2b, and the elastic springs 4a and 4b remove an unnecessary portion, are really carried out and are formed. To the usual metal, since a silicon substrate is a single crystal, also to very many crookedness from there being not only little variation in a load rate, but the above-mentioned elastic springs 4a and 4b having high endurance, there is little deterioration of a load rate and it has the ideal long mechanical property of a life. As mentioned above, the solid state image sensor 5 is formed in the surface of a stage 1, and the light (image) from the candidate for photography by which incidence is carried out from a Z direction carries out image formation to the surface of a solid state image sensor 5 with a lens. As a solid state image sensor 5, although CCD and MOS mold image sensors are used from a small and lightweight viewpoint, especially in this invention, a class is not limited, for example.

[0017] The opening is formed so that the both-ends support bimorph elements 6a and 6b can be inserted in, and it is fixed to the silicon substrate after inserting the both ends of SIMM 8 of both ends in frame 2a and 2b. the both-ends support bimorph elements 6a and 6b -- impression of the voltage of amphipathy -- a part for a center section -- max -- displacement -- it considers as a point and curves in the direction parallel to a stage side. For this reason, the solid state image sensor 5 formed in the surface of a stage 1 is electrically movable to the location of the arbitration of X shaft orientations and Y shaft orientations by fixing a part for the center section of the both-ends support bimorph elements 6a and 6b to the pivots 7a and 7b formed in a part for the

center section of a stage 1 and frame 2a. For example, frame 2a of SIMM 8 both ends, immobilization in 2b, and immobilization with the center section of the both-ends support bimorph elements 6a and 6b and Pivots 7a and 7b are possible with the adhesives of an epoxy system etc. The both-ends support bimorph elements 6a and 6b do not generate any angular moments other than the force of the migration direction theoretically in a part for a center section, in order to perform displacement movement which curves focusing on a part for a center section. However, in an actual element, some angular moment occurs according to the rigid difference between the unevenness of a piezo electric crystal, or the fixed portion of SIMM 8 both ends etc. For this reason, by permitting rotation by using Pivots 7a and 7b as the supporting point, this angular moment can be removed and the force of a required driving direction can be acquired.

[0018] Four elastic springs 4b prepared between four elastic springs 4a prepared between a stage 1 and 2nd frame 2b, 1st frame 2a, and 2nd frame 2b is shown by drawing 1 . Elastic spring 4b shown in the lower right of drawing 1 is expanded and shown in drawing 2 . Moreover, in drawing 1 , four elastic springs 4a supports a stage 1 to 1st frame 2a, and four elastic springs 4b is supporting the stage 1 to 2nd frame 2b. In the example of drawing 1 , although four elastic springs 4a and 4b are used respectively, further two or more elastic springs may be used for them. In addition, a stage 1 is held by both-ends support bimorph element 6b at 2nd frame 2b, and 2nd frame 2b is held by both-ends support bimorph element 6a at 1st frame 2a. Therefore, it can avoid forming elastic spring 4a in the both-ends support bimorph element 6a side, and can avoid forming elastic spring 4b in the both-ends support bimorph element 6b side. When the both-ends support bimorph elements 6a and 6b operate, in order to make it effect not arise in the load rate, total of four load rates of elastic spring 4a or total of four load rates of elastic spring 4b chooses the small value which can be disregarded to the load rate of the both-ends support bimorph elements 6a and 6b. Moreover, elastic spring 4a needs to give the highest possible rigidity in the direction of a right angle with the migration direction, in order to stop an unnecessary cross talk, when both-ends support bimorph element 6b operates. Elastic spring 4b also needs to give the highest possible rigidity in the direction of a right angle with the migration direction, in order to stop an unnecessary cross talk similarly, when both-ends support bimorph element 6a operates. Furthermore, the elastic springs 4a and 4b need to give high rigidity to Z shaft orientations, in order to suppress bending by Z shaft orientations perpendicular to a stage side as much as possible. In this example, from the above viewpoint, as shown in drawing 2 , an elastic spring has the cross section where it is thin and an aspect ratio is high in a driving direction as compared with the thickness of a substrate, and has made it the perpendicularly long configuration in the direction of operation further.

[0019] Although shown neither in drawing 1 nor drawing 2 , in this example, it wires the drive power supply of an actuator etc. in the surface of the elastic springs 4a and 4b at a power supply and an image output signal required for actuation of a solid state image sensor 5, and the pan. The signal from a stage 1 can be further derived to the exterior of frame 2a through frame 2b. These wiring is the same as the wiring used for the usual semiconductor used for formation of a solid state image sensor 5, and can wire formation and coincidence of a solid state image sensor 5. In order to realize the long elastic springs 4a and 4b, an I character mold is sufficient as the plane view configuration of the elastic spring concerned, and as shown in drawing 1 or drawing 2 , it may be bent in the configuration of U characters. When the difference arose in four configurations of elastic spring 4a, or when a difference arises in four configurations of elastic spring 4b, a possibility of generating the moment in addition to a driving direction is high. For this reason, it is necessary to form each elastic spring in the configuration of homogeneity as much as possible. When a configuration forms the elastic spring of homogeneity, silicon micro machine technology is effective. As such silicon micro machine technology, there is a method of processing a direct substrate by an electron discharge method etc., for example by using diacid-ized silicon as a mask as the high-speed reactive ion etching processed using the reactant ion of fluorine system gas, and the processing method of not using a mask. Moreover, semiconductor materials, such as for example, not the thing to limit to silicon but diacid-ized silicon, sapphire, niobic acid lithium, and a gallium arsenide substrate, can be used as the quality of the material of the stage 1 by this invention.

[0020] Next, the formation sequence of a solid state image sensor 5 and the elastic springs 4a and 4b is explained using drawing 3 (A) and drawing 3 (B). First, the proper silicon wafer 31 is prepared (step 1), on the wafer 31 concerned, the usual process is used and two or more solid state image sensors 5 and the various wiring 32 are formed (step 2). In that case, the gap of the mutual solid state image sensor 5 prepares the crevice in consideration of the magnitude of the elastic spring behind formed in the perimeter of each solid state image sensor 5. The surface of the solid state image sensor 5 concerned is beforehand protected in the resist 33 grade next so that the formed solid state image sensor 5 may not be damaged (step 3), and the elastic springs 4a and 4b are processed according to the above-mentioned micro machine process (step 4). A resist 33 is removed after that (step 5), and it cuts for a chip 35 (step 6). Thereby, the stage 1 where the solid state image sensor 5 was formed in the surface can manufacture in large quantities and cheaply the structure held with the elastic springs 4a and 4b. Then, after a micro machine process is completed, the both-ends support bimorph elements 6a and 6b are mounted (step 7).

[0021] In drawing 3 (A) and (B), although the case where the elastic springs 4a and 4b were formed was explained, after forming the elastic springs 4a and 4b, it cannot be overemphasized that a solid state image sensor 5 may be formed. Next, the details of a both-ends support bimorph element (6a, 6b) are explained using drawing 4 and drawing 5 . In drawing 4 , a both-ends support bimorph element consists of SIMM 8 and piezo electric crystals 9a and 9b. Usually, a sheet metal is used for SIMM 8 and piezo electric crystals 9a and 9b are stuck on both sides. Piezo electric crystals 9a and 9b have polarization of a mutually different direction, and when they impress the polar voltage shown in drawing to the both-ends support bimorph element shown in drawing 4 , as illustrated, they curve centering on a center section on the basis of the both ends of SIMM 8. If polar voltage opposite to drawing is impressed similarly, it will curve to an opposite direction. For example, by length of 10mm of a piezo electric crystal, and the about [ thickness 0.3mm ] both-ends support bimorph element, the amount of displacement of **50 micrometers and driving force 30mN can be obtained by applying about [ **50V ] voltage. It follows, for example, when only

the distance equivalent to 1 pixel moves CCD of the magnitude whose pixel is about 5 micrometers, it can drive by 5V single power supply used by the usual pocket device.

[0022] Moreover, the element from which a mechanical configuration changes with the heat which made the dissimilar metal rival, such as bimetal and a shape memory alloy, in drawing 5 as an actuator of a use with which drive speed seldom poses a problem may be used. When using these elements, movement magnitude can be electrically controlled by sticking on an element the heat source which generates heat with electrical and electric equipment, such as a heater. The example of the actuator which stuck the heat source on drawing 6 at the element is shown. In drawing 6 , 10 and 11 are the bimetal which made the metal with which coefficients of thermal expansion differ rival, and 12 is a resistor. In order that the quantity of heat which joins bimetal may change electrically by applying voltage to a resistor 12, a stage is electrically movable like both-ends support bimorph.

[0023] The [2nd example] The 2nd example of this invention is explained to drawing 7 . In addition to the component shown by drawing 1 , in drawing 7 , the position-sensor substrate 13 for getting to know the location of a solid state image sensor 5 is newly added. The position-sensor substrate 13 held the narrow gap between the solid state image sensors 5 formed in the surface of a stage 1, and has countered it, and the aperture 14 is formed so that the light from Z shaft orientations may be irradiated by the surface of a solid state image sensor 5. A bump 16 is the pillar of the conductive hard drum type metal which used solder etc., and maintaining the narrow gap below several micron meter between the position-sensor substrate 13 and a solid state image sensor substrate, while she fixes a relative position mechanically, she plays the role of both electrical installation between substrates. In this example, the electrode for location detection (18a and 18b show at drawing 7 ) is formed in the near field in which the solid state image sensor 5 of a stage 1 is formed, and the electrodes 18c and 18d for location detection are formed in the part which counters the electrodes 18a and 18b for location detection of the stage substrate 13. In this example, the location of the solid state image sensor 5 formed in the surface of a stage 1 can be known from change of the electrostatic capacity formed between the electrodes 18a and 18b for location detection, and the location detection electrodes 18c and 18d.

[0024] In the example of drawing 7 , the case of being thicker than a stage substrate is shown, the location of two substrates is shifted and width of face of two both-ends support bimorph elements, the X-axis and a Y-axis, 6a and 6b is mounted so that the edge of the position-sensor substrate 13 may not be hit. Both substrate can also be completely piled up by using the both-ends support bimorph elements 6a and 6b with width of face narrower than the thickness of a stage substrate. Drawing 8 shows the example in the case of enclosing with a package 17 the solid state camera shown in drawing 7 . The slot is formed in order that the both-ends support bimorph elements 6a and 6b may not contact a package 17 in the base of a package 17 in drawing 8 . Furthermore, while the lid 15 of a package uses the resin of the glass which penetrates light, or transparence and applies light to an image pick-up side, the airtight effect for protecting a solid state image sensor 5 and the both-ends support bimorph elements 6a and 6b from humidity or dust is achieved.

[0025] The details of the position sensor for getting to know the location of a solid state image sensor 5 to drawing 9 are shown. Signs that a solid state image sensor 5 and electrode 18a for location detection were formed in the stage 1, and the pad electrodes 20a and 20b were formed in 2nd frame 2b in drawing are shown. Electrode 18a for location detection is connected to pad electrode 20a through wiring 19a, and the signal terminal of a solid state image sensor 5 is connected to pad electrode 20b through wiring 19b. Location detection electrode 18a is equipped with electrode 18c for location detection of the configuration same as shown also in drawing 7 as the portion which the position-sensor substrate surface counters, and both electrodes form the parallel plate capacitor across a narrow gap. For this reason, the location of a stage can be known by constituting an AC bridge etc. and detecting change of the electrostatic capacity produced from change of the lap area of the electrode accompanying migration of a stage 1. For this reason, without needing components special for location detection, it is very small and the location detector where sensitivity is high can be offered. Although for that the necessity of taking out the signal of electrode 18a for location detection to the exterior of a stage 1 arises, it is realizable by forming wiring 19a along the surface of the elastic spring 4. Similarly, the power supply and image output signal of a solid state image sensor 5 can also be taken out outside a stage 1 through wiring 19b. These signals taken out from the stage 1 are electrically connected to a position-sensor substrate through the bump who formed on pad electrode 20a and 20b. Similarly, the driver voltage of both-ends support bimorph element 6a required for the drive of the X-axis can also be supplied by forming wiring as ****** of the elastic spring which supports a Y-axis. Before silicon micro machine processing, beforehand, a semiconductor process is used and these wiring and electrodes can form it easily.

[0026] The suitable block diagram of a control unit for the position control of a solid state image sensor is shown in drawing 10 . In drawing 10 , both-ends support bimorph element 6b (here bimorph piezoelectric device 121) shown in drawing 1 or drawing 7 is driven, and the control unit for moving in the direction of X on the stage 1 (here, a sign 123 showing) shown in drawing 1 or drawing 7 is shown. drawing 10 -- setting -- a control unit -- the bimorph piezoelectric device 121 -- in addition, a position sensor 122 (electrodes 18a-18d for location detection as shown by drawing 7 or drawing 8 ), D/A converter 124, and the error amplifier 125 -- about -- it is constituted including the phase compensating network 126 and the bimorph drive circuit 127. The bimorph piezoelectric device 121 moves a stage 123 by impressing driver voltage. As already stated, the stage 123 carries the solid state image sensor. Moreover, the position sensor 122 is formed in the stage 123, and the location (namely, location of a solid state image sensor) of the stage 123 concerned can be known by change of electrostatic capacity. The output of such a location sensor 122 is an analog signal (for example, direct current voltage) corresponding to the location of a stage 123. D/A converter 124 is inputting the position control data corresponding to the location of a stage 123, and outputs the direct current voltage corresponding to a location. The error amplifier 125 amplifies the difference of the output voltage of D/A converter 124, and the output voltage of a position sensor 122, and supplies driver voltage to the bimorph piezoelectric device 121 through the phase compensating network 126 and the bimorph drive amplifier 127. namely, the control unit of drawing 10 -- setting -- the

output voltage of the error amplifier 125 -- zero -- in other words, it will be controlled so that the output voltage of D/A converter 124 for position control and the output voltage of a position sensor 122 always become equal, and the digital control of the location of a stage 123 can be carried out to arbitration by setup of position control data.

[0027] In the positional controller of drawing 10 , the error amplifier 125 detects the difference of the output of a position sensor 122, and the output of D/A converter 124, and although the case where hood back control is performed is shown so that the difference of an input of the error amplifier 125 may become zero, the so-called feedforward method which supplies the output of D/A converter 124 to the direct bimorph drive circuit 127 to this, and feeds back only difference with the location expected through the error amplifier 125 can also be used together. According to this, as compared with the case where only feedback is used, the control circuit which has a wide band more is realizable using a control circuit with fewer open-loop gain. for this reason, the thing done for adjustable [ only of the damping property in a self-resonant point ] by adjustment of the phase compensating network 126 and a closed loop gain as compared with the case where position control is not performed -- possible -- a stage 123 (namely, solid state image sensor) -- a high speed -- in addition -- and a ringing is movable few.

[0028] Although the control unit about the X-axis was shown, the stage 1 shown in drawing 1 is controllable independently by the example of drawing 10 also about a Y-axis having one more same control unit. The suitable solid state image sensor for the application to a portable digital still camera, video, etc. can be offered by combining such a controlling mechanism with a microcomputer etc. Moreover, a solid state camera with the stable migration means which is not influenced [ of nonlinear characteristics such as effect of property change, a hysteresis, and a creep, ] by the temperature change of the bimorph actuator made into the problem by the migration device of a solid state camera can be conventionally offered by the above-mentioned control. For this reason, there is an advantage which can expect the actuation which did not adjust in extensive temperature environment and was stabilized. Furthermore, since control of a location is always performed, the actuation extremely stabilized to the mechanical shock from the outside is possible, and it is suitable for the pocket device used by the radical of the environment by which vibration is always accompanied.

[0029] The [3rd example] The 3rd example of this invention is explained using drawing 11 . In drawing 11 , a gap is opened in the side in which the solid state image sensor 5 of a stage 1 is not formed, and the position-sensor substrate 13 is formed in it. The electrodes 18a and 18b for location detection are formed in the side in which the solid state image sensor 5 of a stage 1 is not formed, and the location detection electrodes 18c and 18d are formed in the field by the side of the stage 1 of the position-sensor substrate 13. It is the same as that of the example shown in drawing 7 that the location of the solid state image sensor 5 formed in the surface of a stage 1 from change of the electrostatic capacity formed between the electrodes 18a and 18b for location detection and the location detection electrodes 18c and 18d can be known. In the 3rd example, there is an advantage without the necessity of forming an aperture 14 like the 2nd example in the center section of a position-sensor substrate. The effect acquired in the method which controls the location of a solid state image sensor 5 by high degree of accuracy using a position sensor, and that case is completely the same as the 2nd example.

[0030] The [4th example] Next drawing 12 is used and the 4th example of this invention is explained. Although the 3rd example explained the case where a solid state image sensor 5 and the elastic springs 4a and 4b were collectively formed in a single silicon substrate to the example, even if it pastes up or welds the solid state image sensor substrate 21 which formed only the stage 1 which does not have a solid state image sensor 5 from a single silicon substrate, and the elastic springs 4a and 4b holding it, and was formed according to the individual to the surface of a stage 1, the effect of this invention is not spoiled at all. In this case, as shown in drawing, the pad electrode 22 for wire bonding is beforehand formed in the perimeter of a stage 1, and after pasting up the solid state image sensor substrate 21 on the surface of a stage 1, between the pad electrode 22 of the solid state image sensor substrate 21 surface and the pad electrodes 23 on a stage 1 is electrically connected by WAYA bonding. Since it connects with the exterior of frame 2b electrically through the wiring on elastic spring 4a and 4b as mentioned above, the bonding pad electrode 22 on a stage 1 can connect the output signal of the solid state image sensor substrate 21, a power supply required for actuation, etc.

[0031] According to the 4th example, if a stage 1 and the elastic springs 4a and 4b are the materials which are the same materials and can be formed by one, it will not necessarily be limited to silicon. For example, it is resin, such as metals, such as stainless steel, a ceramics material, glass material, and plastics, a glass epoxy group board, etc., and it cannot be overemphasized that it will not matter if it is the material which can wire the surface. Moreover, it is also possible to mass-produce the integral construction of a stage, an elastic spring, and a frame with injection molding which used metal mold when glass material, resin, etc. were used.

[0032] In the 1st, 2nd, and 3rd examples, in order to form a solid state image sensor 5 and an elastic spring on the same silicon substrate beforehand, the number of the solid state image sensors which can be formed on the silicon wafer of the same size as compared with the case where only a solid state image sensor is formed will decrease. Moreover, when a defect is in any of a solid state image sensor and an elastic spring they are, all the image sensors will become a defective. On the other hand, in the 4th example, since the solid state image sensor 5 of the excellent article which examined beforehand, and the migration device of an excellent article in which a stage 1 and the elastic springs 4a and 4b were formed are combinable, there is an advantage which can improve the yield. Furthermore, since the mass for moving part can be reduced to the value almost near the solid state image sensor itself as compared with the solid state image sensor which has the migration device of the conventional example according to the 1st to 3rd example of this invention, it is easy to improve the self-resonant frequency of a drive system to 2kHz or more as compared with conventional 300-400Hz. for this reason, the conventional example -- comparing -- a solid state image sensor -- a high speed -- in addition -- and it can move by few ringings. For this reason, when it applies to a digital still camera especially, it can respond to photography of a quicker shutter speed.

[0033] The [5th example] The case where this is applied to the digital image pick-up device (here digital still camera) of this invention is explained to the 4th as the control method of the location of a solid state image sensor common to the example of the solid state camera of a publication as the 5th example from the 1st. First, the art of the data in the case of applying the above-mentioned solid state camera to a digital still camera is explained. Since it is easy for drawing 13 , the example in the case of controlling the location with four pixels of CCD is shown. In drawing 13 , Pixel PXL opens the gap for 1 pixel in a light-receiving side in all directions, and is prepared in it. The pixel which was in a1 location at the period when the shutter serves as open picturizes moving to the location of a2, a3, and a4 one by one. In this example, the image which has high resolution equivalent to CCD which has one 4 times the number of pixels of this equivalent can be obtained by compounding the image acquired by a series of four migration among one closing motion of a shutter (while the shutter is open). Although the example of drawing 13 explained the case where migration in the location of four places was performed to the example, the migration sequence of the illustrated pixel may not be limited to a1 ->a2 ->a3 ->a4, and the reverse is sufficient as it. In addition, in the case of a solid state camera with one frame, a solid state image sensor moves only in the one direction (X-axis or Y shaft orientations), and, in the case of a solid state camera with two frames explained in each above-mentioned example, usually moves to a 2-way (X-axis or Y shaft orientations). Therefore, in order to obtain higher resolution, a solid state camera with two frames is suitable.

[0034] The [6th example] The application to the digital still camera which can process and record the image data obtained by the example in the case where a solid state image sensor moves to four places of drawing 13 is shown as the 6th example using drawing 14 . In drawing 14 , the digital still camera consists of a lens 131, the electronics control shutter 132, a solid state image sensor 133 (solid state image sensor movable to the X-axis and Y shaft orientations which were stated in each above-mentioned example), A/D converter 134, buffer memory 135, picture compression equipment 136, a positional controller 137, CPU138, and data storage 139. According to the shutter signal S, CPU139 computes the open aperture time of an electronic shutter 132 from exposure data, and controls an electronic shutter 132 by the shutter control signal SC. Furthermore, CPU138 gives the position control signal P for moving a solid state image sensor 133 to four places to a positional controller 137, a positional controller 137 is controlled to move the light-receiving side of a solid state image sensor 133 to one fourth of the time amount every ] X-axes and/or Y shaft orientations of shutter speed according to this, and a solid state image sensor 133 picturizes in each location. A positional controller 137 consists of circuits already explained by drawing 10 .

[0035] While the electronics control shutter 132 opens and closes (while being in the open condition), a solid state image sensor 133 moves to four places, and photos four images. Four picture signals G1-G4 from a solid state image sensor 133 are changed into digital data by A/D converter 134, and are recorded on four fields 135a-135d to which buffer memory 135 differs respectively one by one as image pick-up data DG1-DG4. After the electronics control shutter 132 closes, reading appearance of each image pick-up data DG1-DG4 of four images is carried out collectively, and after being compounded by one image G in which a solid state image sensor 133 has the number of pixels 4 times the resolution of having physically, a data compression is carried out in picture compression equipment 136, and it is recorded on the data storage 139 as compression image data CG. As the compression method of data, the picture compression algorithm of the so-called JPEG and MPEG1 grade can also be used. In addition, the only compounded image data may be recorded, without compressing, when there is sufficient additional coverage for the data storage 139. Moreover, by carrying out adjustable [ of the division field of buffer memory 135 ] to arbitration, in the open aperture time of a shutter, it is also possible to move a solid state image sensor 133 to the part of arbitration, and resolution can be changed to arbitration and can also be recorded by this. Moreover, according to the example of this invention, as compared with the solid state image sensor which has the conventional migration device, it becomes movable [ the count of many in the bottom of the same shutter speed ], since migration with a solid-state is possible at high speed more. For this reason, an image with more high resolution can be obtained.

[0036]

[Effect of the Invention] According to this invention, the following effects can be done so as stated above.

(1) Since a solid state image sensor and a migration device are really carried out and can be formed with micro machine technology using the same silicon substrate, the cheap solid state image sensor suitable for mass production method can be offered.

(2) Since small [ of a migration device ] and lightweight-ization are realizable, as compared with the conventional example, it can respond to photography of a quicker shutter speed. Moreover, in the conditions of the same shutter speed, an image sensor becomes movable and photography of higher resolution is possible.

(3) An image with high resolution cheap and equivalent to having taken a photograph with the solid state image sensor with many pixels equivalent using the solid state image sensor with few pixels can be obtained.

(4) By using the actuator which consists of a both-ends support BAIMORU element, the large range not only of the conventional direction of a single dimension but the direction of two dimension can be provided with a movable solid state image sensor.

(5) It is not influenced of nonlinear characteristics, such as badness of the temperature characteristic done the problem by the control using a position sensor in the solid state camera without the position control device only using the conventional bimorph actuator, and a hysteresis, a creep, but a solid state image sensor still stronger against an impact from the outside can be offered.

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[Translation done.]